Designing Intelligent Fishcarelab System (IFS) as Modern Koi Fish Farming System

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Abstract— **The design of the pond for intelligent koi fish farming system proposed in this paper. This pond is called Intelligent Fishcarelab System (IFS). IFS as fish farming system is Internet-based Remote using IDACS Technology (Internet-based Data Acquisition and Control System). IFS hardware consists of mechanical and electronic systems. Mechanical system consists of water tanks and piping systems. While the electronic system comprises sensors temperature and pH. These sensors include signal conditioning circuit. Furthermore, by using Analog to Digital Converter (ADC) module the data can be read by the microcontroller circuit. Microcontroller circuit is assigned to conduct sensor readings and sends data to the server to inform water conditions. Another electronic system used is the on/off electric valve. Several electronic faucets are also used and their workings are controlled by a microcontroller. With this faucet system, the water supply, as well as the disposal of fish pond water can be controlled electronically. Besides, the system is also equipped with an actuator module, which is used to regulate the temperature and pH in the water. Actuators are also used for fish feeding settings. The microcontroller control module requires Digital to Analog Converter (DAC) and signal conditioning circuit. IFS in the operating system hardware requires microcontroller-based software and web-based software for monitoring and controlling water quality and feeding automatically and scheduled. Furthermore, this system apart can work directly in the area of fish farming can also be monitored and controlled remotely using an Internet connection.**

Keywords—IFS, FISHCARELAB, IDACS, Fish, internet, intelligent

I. INTRODUCTION

Smart and modern fish farming system has been gaining interests in the last two years. Many researchers from around the world published their results such as those of [1], [2], [3], [4], [5], [6]. The research primary results found the relationship between fish growth and water quality in which fishes are farmed [1], [3]. Other research presented empirical modeling techniques based on collection of water quality monitoring data [5]. Besides that, comparison of the utilization ratio of Genetic Programming (Genetic Programming) and Artificial Neural Network (ANN) was used to predict the long-distance water quality based on the image of water [6]. Meanwhile, the results of other studies presented a good chance or a very promising prospect for supplier business of fish feed for the fishing industry [2]. There also research that produced aquaponics farming technique in confined spaces (indoor) automatically. Aquaponics is the integration of hydroponics (plant / vegetable production without soil) and aquaculture (fish farming) [4]. On the other hand fish farming itself as an attempt to get a higher income has also attracted people attention. Freshwater fisheries business has excellent prospects because until now fish supply, either fresh fish or processed one, is still lower than consumer demand [7].

During its farming fish should always be supervised in its growth. Growth is an increase in length or weight in a certain time [8]. Fish growth is influenced by internal and external factors. Internal factors are: body weight, sex, age, fertility, health, movement, acclimation, biomass activity and oxygen consumption. While external factors consisted of abiotic factors and biotic factors. Abiotic factors consist of pressure, temperature, salinity, oxygen content of the water, the waste metabolites (CO2, NH3), pH, light, season. Nutrition factors are among those biotic factors such as availability of food, feed composition, digestibility of feed, and feed-making competition. Among these factors, nutrition is a controlling factor, and the size of the fish affects the growth potential of an individual. The water temperature on the other hand affects the whole activity and fish life processes which include respiratory, reproduction, and growth. If the water temperature increases (to some extent), the metabolic rate increases which in turn increases consumption and growth of fish [9].

Since the growth of fish should be maintained and monitored both in terms of water quality during the farming and availability of food as needed then smart strategy or way to overcome this is required. On the other hand the development of information and communication technology in the development of intelligent systems based on electronics, computers and microcontrollers can be used as alternative solutions to those problems. Therefore, this paper proposes the manufacturing of a new system consisting of hardware and software for fish farming in the form of intelligent equipment systems. Furthermore, the system is named Intelligent Fishcarelab System (IFS). The system is designed not only to be operated directly in the indoor fish farming, but also designed to be monitored and controlled remotely using an Internet connection. Advantages of this equipment in addition to its continuous 24 working hours are its simple installation and use anywhere as long as Internet connection is available.

IFS technology is designed to work using Internet Based Data Acquisition and Control System (IDACS). This technology in previous studies have been successfully used to control soil quality from a long distance [10]. In general, these systems are designed to be used for farming all types of freshwater fish. However, in order to be focused and able to uncover the characteristics of freshwater fish growth, Koi fish was selected as the case study.

Koi (*Cyprinus carpio*) is one type of ornamental fish which for decades from generation to generation cultivated by the Japanese, and even be used as a symbol for the nation of Japan and was appointed as the national fish of Japan. Koi beautiful and diverse color has pushed the Japanese to produce tens of types of Koi that ultimately favored by people in various countries including Indonesia [11].

In Indonesia, Koi is a favorite ornamental fish and much-loved by the public, because of its dazzling color and relatively expensive price. Koi is still one of the commodities traded fairly in the field of fisheries. The presence of Koi in a family has always a positive effect. If it is farmed on a large scale can be used as a living as well as to create new jobs. Meanwhile, when maintained on a small scale like decorative fish, Koi can be used as a means of recreation by observing the beauty and its supple, graceful and swaying motion in the aquarium [12]. At Koi breeding, hatchery operations play an important role in the provision of seeds to be raised to the dyeing process to achieve perfection. Koi quality is determined by its color pattern, type suitability and clarity of color. Symmetrical color pattern with clear boundaries between colors indicate good quality.

1.1 Koi Fish Taxonomy

Koi fish belong to the class of carp fish (carp). Breeding which has been done for many years produce lineages that became standard for Koi assessment. The Koi fish classification according Khairruman [13], namely:

Filum	:	*Chordata*
Sub filum	:	*Vertebrata*
Superclass	:	*Pisces*
Class	:	*Osteichthyes*
Sub class	:	*Actinopterygii*
Ordo	:	*Cypriniformes*
Sub ordo	:	*Cyprinoidea*
Family	:	*Cyprinidae*
Sub Family	:	*Cyprininae*
Genus	:	*Cyprinus*
Species	:	*Cyprinus carpio*

1.2 Koi Fish Morphology

According to [11], Koi body shaped like a torpedo with fins as means of motion. Fins that complements its shape morphology is a dorsal fin, a pair of pectoral fins, a pair of pelvic fins, an anal fin, and a tail fin. To serve as a tool motion, this fin consists of hard fingers, soft fingers and fin membranes. Pectoral fins and caudal fin has only soft fingers. Dorsal fin has 3 hard fingers and 20 soft fingers. Pelvic fin only has 9 soft fingers. The anal fin has 3 hard fingers and 5 soft fingers.

On the side of his body, from the middle of the head to the tail rod, there is a lateral line which is useful for sensing sound waves. This line is made up of veins that exist on the scales that looms up outside. Koi bodies are covered with 2 layers of membrane. The first layer is located outside the so-called epidermis, while the inner layer called the endodermis. The epidermis consists of cell saps that produce mucus on the surface of the body of the Koi. Endodermis layer consists of fibers filled with cells. In this layer there is also a color cell.

This color cell has a very complex pattern. It produces a solution of 4 different kinds of color cells by using contraction. Those four cells are melanophore (black), xanthophore (yellow), erythrophore (red), and guanophore (white). The taste organs and nerves have a close relationship with the absorption and shrinkage of color cells. These organs are very reactive to light. Their place is located between the epidermis and nerves in the fat tissue, which is located under the scales.

1.3 Environment and Nature

Koi fish likes to live in shallow fresh water with slow water motion, for example at the edge of a river or lake. This fish can live well at an altitude of 150 - 600 meter above sea level and at a temperature of 25 - 30 ºC. Although classified as freshwater fish, koi fish sometimes also found in brackish waters or in estuaries with salinity of 25 - 30% [13].

Koi easily adjust to its environment. This fish can occupy almost all places. At the time of transfer, it is advised to prevent Koi from undergoing sudden changes. Koi life span is generally up to 70 years, but there are some that can live up to 200 years. There is not a leader in a group of Koi, and neither is rough male that disturb female Koi. As an old newcomer, Koi will not torture newcomers. Koi are very gentle [11].

1.4 Food and Eating Habits

Koi fish species are classified as omnivores, ie. fish that can prey on a variety of foods, both from microscopic plants and animals. However, the main foods are plants and animals which are available at the river/sea floor and on the waterfront [13]. According to [11], Koi is willing to eat meat, fish, vegetables and even bread. But to get a healthy Koi with alluring colors, it is advised to feed Koi with artificial food. The artificial feed is a mixture of vegetable and animal ingredients plus vitamins. This artificial food is good for the growth of Koi body color. In addition to artificial food, Koi also need natural food such as shrimps, crustaceans, earthworms, crabs, and snails. Comparison of plant materials and animal material ranges from 6: 4.

II. METHOD

The proposed Pond IFS design as a remote Internet-based fish farming system is illustrated in Fig. 1. Water from an underground reservoir will stop automatically if Elevation Level reaches a certain level. Water levels are known through the Level Sensor (S1) readings. Other sensors utilized to monitor the quality of water are a Temperature Sensor (S2) and pH Sensor (S3). Sensors readings are then amplified or conditioned using signal conditioning circuit module. Furthermore, by using the analog to digital converter circuit or Analog to Digital Converter (ADC) signal conditioning circuit module data readings can be read by the microcontroller circuit. Furthermore, the microcontroller circuit module is assigned to conduct the reading of the output signal conditioning circuit module and transmits the data to the server. Server works based on pond water quality monitoring and controlling program. The server is also responsible of feeding the fish according to the ideal fish growth standard.

Microcontroller is equipped with actuator module and Electric Valve (V1) to control the distribution of water into the pond. It is also equipped with Electric Valve (V3) to regulate the discharge of water for the replacement of pond water. Microcontroller is equipped with Regulator Module (P1, P2) for regulating water conditions (temperature and pH) as needed. Temperature and pH settings are required so that Koi fish has ideal environment for its growth. The microcontroller also features an actuator module for regulating fish feeding as needed. Open and close the faucet of food reserves by turn on and off the Electric Valve (V2). Furthermore, using web-based program data readings can be displayed.

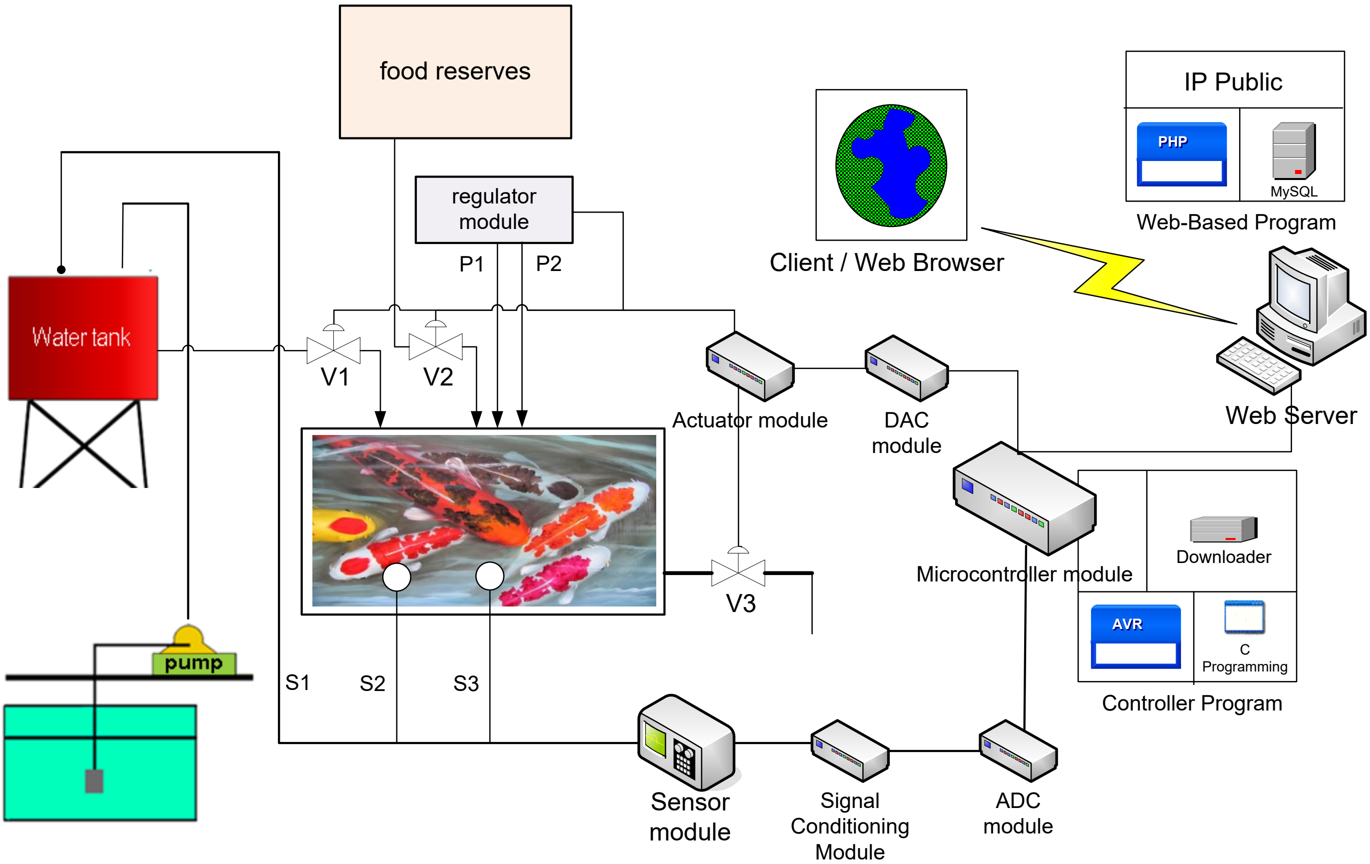

Fig. 1. Intelligent Fishcarelab System (IFS) Architecture

How to monitor and control the pond water temperature and pH over the internet is by using the standard Hypertext Transfer Protocol (HTTP) and Hypertext Markup Language (HTML) and access it via TCP / IP. The concept of client/web browser to browse to the server to be able to access the microcontroller requires several components, i.e. the client computer as a web browser, web server, text file whose contents can be changed in accordance with the writing done on the client, an HTML document generated by the Controller Program and displayed together with readings Controller Program of the microcontroller. The Microcontroller Module access mechanism through the Internet network can be seen in Fig. 2.

The algorithm for monitoring and controlling the temperature and pH of pond water using On/Off controller is shown in Fig. 3. That is by turning on and off Regulator

Module. The mechanic system of Regulator Module is assumed to have been working as needed.

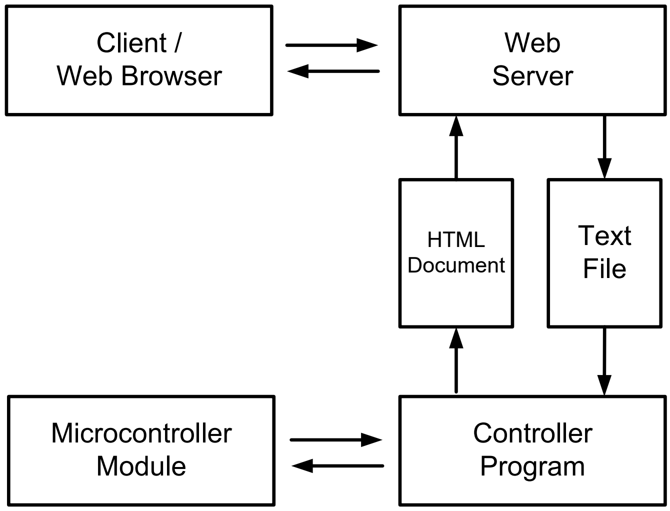

Fig. 2. The Microcontroller Module access mechanism through the Internet network

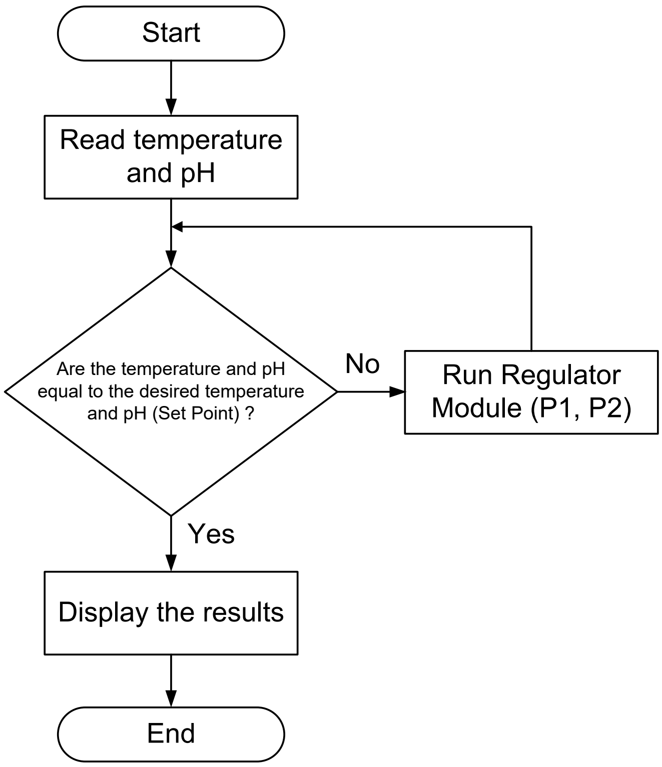

Fig. 3. Monitoring and controlling algorithm

III. RESULTS AND DISCUSSION

Pond IFS research result is shown in Fig. 4. Testing Results of the temperature and pH readings compared with the results of the calibrator as the desired setpoint values are shown in Table I. The difference is expressed in root mean squared error (RMSE) and mean absolute percentage error (MAPE).

Fig. 4. Pond IFS

TABLE I. TESTING RESULT OF TEMPERATURE AND PH

Temperature (°C)		**pH**	
IFS	***Setpoint***	***IFS***	***Setpoint***
27.87	27	8.2	8.3
27.87	27	8.2	8.3
27.87	27	8.17	8.3
27.81	27	8.17	8.3
27.81	27	8.16	8
27.81	27	8.16	8
27.75	27	8.16	8
27.75	27	6.98	7
27.69	27	6.98	7
27.69	27	6.98	7
RMSE	0.7947	RMSE	0.1148
MAPE	2.9333	MAPE	1.2399

From the temperature testing result, it can be seen that difference between IFS and the setpoint is small (RMSE < 1° and MAPE < 3 %). pH testing result also similar with RMSE < 0.12 and MAPE < 1.3%. It can be concluded that pond IFS can be used as an alternative for koi fish farming system.

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